**DETERMINATION OF METEORITE POROSITY USING LIQUID NITROGEN.** T. Kohout[1, 2, 3], G. Kletetschka[3, 4, 5], L. J. Pesonen[1] and P. J. Wasilewski[5], [1]Division of Geophysics, Department of Physical Sciences, University of Helsinki, Helsinki, Finland, tomas.kohout@helsinki.fi, [2]Department of Applied Geophysics, Faculty of Science, Charles University in Prague, Prague, Czech Republic, [3]Institute of Geology, Academy of Sciences of the Czech Republic, Prague, Czech Republic, [4]Department of physics, Catholic University of America, Washington DC, USA, [5]NASA Goddard Space Flight Center, Code 691, Greenbelt, MD, USA.

**Introduction:** We introduce a new harmless method for porosity measurement suitable for meteorite samples. The method is a modification of the traditional Archimedean method based on immersion of the samples in a liquid medium like water or organic liquids. In our case we used liquid nitrogen for its chemically inert characteristics.

**Liquid nitrogen specifics:** Compared to conventional liquids used in laboratory research (water, toluene) the liquid nitrogen (77 K) must be kept in a dewar bottle at all times in order to prevent boiling. The dewar bottle must be equipped with a wide neck to allow introduction of the samples in the liquid nitrogen.

The air above the liquid nitrogen level, inside dewar bottle, must be replaced with a continuos flow of precooled nitrogen gas. This procedure helps to prevent the freezing of atmospheric carbon dioxide and moisture on the dewar walls and the samples itself.

Treating the samples under cryogenic conditions requires special sample care. The sample must be kept for one hour in the cold region (cold gas nitrogen atmosphere) just above the liquid nitrogen level in order to thermally equilibrate. This reduces the danger of sample fragmentation due to the rapid temperature change as well as the boiling of liquid nitrogen while immersing the warm sample. Similar procedure of slow sample warming during sample removal from dewar must be executed.

The formation of carbon dioxide and water ice is a problem that is controlled by the above described procedures.

**Sample pre-treatment:** The samples are dried in an oven at temperatures ranging from 320 K to 400 K (higher temperature reduces drying time, but can start chemical changes in the material) for a couple of days. Before introducing the samples into liquid nitrogen the samples are inserted in a vacuum chamber. After the air is pumped out the pump is stopped and the chamber is backfilled with nitrogen gas. This procedure is repeated five times. The aim of this procedure is to remove any remaining moisture and gases from pore space and to fill the pore space with gaseous nitrogen (the same chemical is used as liquid medium). It is important to remove all chemical phases with freezing points above 77 K (such as water and carbon dioxide) from the pore space. Otherwise, the freezing products can plug pore space what will result in a porosity underestimation and possible sample damage (volume expansivity of water ice).

**Porosity measurement and calculation:** The porosity $p$ is determined from the equation:

$$p = (m_{sa} - m_{ea}) / (m_{sa} - m_{sl})$$

$m_{sa}$ - mass of sample in air with saturated pores
$m_{ea}$ - mass of sample in air with empty pores
$m_{sl}$ - mass of sample in liquid with saturated pores

The mass of the samples both in air and immersed in liquid nitrogen is determined by weighting them hanged on a thin wire connected to the digital balance. Computer acquisition of the data allows acquiring precise weight as a function of the time in order to monitor the process of pore space saturation by liquid nitrogen.

**Results:** We tested the technique using irregular brick samples and found comparable results using using liquid nitrogen and water mediums.

One primary advantage of the nitrogen method is its chemically inert characteristics. The possibility to measure irregular shaped samples (no need to determine sample volume) make this low cost method suitable for irregularly shaped meteorite samples. The only chemical coming in contact with the samples is liquid and gaseous nitrogen. Gaseous nitrogen is widely used in laboratories and industry as an inert atmosphere and is the most abundant chemical compound in terrestrial atmosphere (78 %). Exposure of the samples to cryogenic temperatures (77 K) is not critical. Meteorites were exposed to this wide temperature range before their encounter with Earth and the porosity value at 77 K due to temperature contraction of the material is much closer to the real "space" porosity of interplanetary material. The disadvantage is the long time of the measurement (around one week). However, set of several samples can be used during a measurement campaign.

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